

# Driving Characteristics Analysis of an Electric Garbage Collection Truck and Optimization of Speed Change Patterns for Reducing Electricity Consumption

- A Study on Door-to-Door Waste Collection Driving -

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## 1. Introduction

Electric garbage collection trucks provide low-carbon, low-noise, and low-environmental-impact operation. Their characteristic speed change patterns, involving frequent starts and stops, may also be more suitable for electric vehicles than for diesel-powered vehicles. This study investigates the benefits of electrifying garbage collection trucks using a fuel-cell waste collection truck. The analysis focuses on door-to-door waste collection driving. In addition, two representative trips were selected for optimization of their speed change patterns, and the potential reduction in electricity consumption was evaluated under identical travel-distance and average-speed conditions.

## 2. Overview of the Field Operational Test and Test Vehicle

A field operational test of an independently developed fuel-cell waste collection truck was conducted in Tama City from May 22 to July 7 and from October 2 to December 19, 2023. This study mainly examined door-to-door collection operations for detached houses. The operations on May 29, June 8, and July 3, which involved relatively large amounts of collected waste, were analyzed as representative cases. As shown in Table 1, the operation was divided into waste transport driving and door-to-door waste collection driving. The specifications of the test vehicle, “Tama-go,” are also listed in Table 1.

## 3. Research Findings

The principal findings are summarized as follows.

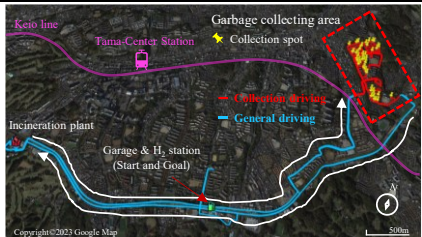
(1) Door-to-door waste collection driving is characterized by low speeds, short travel distances, frequent starts and stops, long stationary periods, and equipment operation while stationary. These conditions are unfavorable for diesel vehicles but may benefit from the high starting and acceleration performance of electric vehicles.

(2) Energy analysis showed that regenerative energy recovery was negligible, whereas auxiliary systems accounted for a substantial share of electricity consumption. Therefore, although this operating scenario is highly unfavorable for diesel vehicles, it is also a very special condition for electric vehicles and can easily lead to increased electricity consumption.

(3) The speed change patterns were similar, and their shapes and maximum speeds were strongly dependent on the distance between collection locations. This facilitates the definition and optimization of representative eco-driving speed change patterns. Because the operation is generally less affected by surrounding traffic, the optimized profiles are also considered relatively easy to implement in actual vehicles.

(4) Energy-optimal speed profiles were derived for two representative door-to-door waste collection trips to improve electricity consumption. For the average-speed trip in which regenerative braking was unavailable, the optimized profile consisted of strong acceleration, constant-speed cruising, and mechanical-braking deceleration, reducing electricity consumption by approximately 18%. For the high-speed trip in which regenerative braking was available, the deceleration section combined maximum regenerative braking with mechanical braking, resulting in an estimated reduction of approximately 28%.

Table 1 Specifications of target vehicle and route

|                     | Value                                                                                |
|---------------------|--------------------------------------------------------------------------------------|
| Base vehicle        | Hino Motors “RANGER 4.0t”                                                            |
| Size                | L7080×W2190×H2560 mm                                                                 |
| Curb / Gross weight | 6,230 / 7,830 kg                                                                     |
| Motor system        | Kawamata PMSM 150 kW                                                                 |
| Fuel cell system    | Toyota PEM fuel cell / 60 kW max                                                     |
| Hydrogen tank       | 51 L×2 / 82.5 MPa / 72 kg                                                            |
| Hydrogen loading    | 4.2 kg at 55 °C                                                                      |
| Battery             | Toshiba SCiB™ 26.5 kWh / 336 kg                                                      |
| Vehicle             |  |
| Route               |  |